Nanocrystalline cathodes for PC-SOFCs

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Keywords: *$BaCe_{0.6}Zr_{0.2}Y_{0.2}O_{3-\delta}$, fuel cells, proton conductor, microstructure, impedance spectroscopy.*

1 Abstract

Ceramic proton conductors are of great interest for the development of solid oxide fuel cells (PC-SOFC) operating at relatively low temperatures between 400 and 700 ºC.

Perovskites based on $BaCeO_{3-\delta}$ exhibit the highest proton conductivity among this class of materials, however, they are susceptible to hydration and carbonation in presence of water vapor and CO_2 [1]. In contrast, the chemical stability of $BaZrO_3$-based protonic conductors is better, but they require sintering temperatures as high as 1700 ºC and usually suffer from high intrinsic grain boundary resistance, limiting the final performance. Partial substitution of Zr for Ce in $Ba(Ce_{0.9-x}Zr_x)Y_{0.2}O_{3-\delta}$ allows obtaining electrolytes with both high proton conductivity and good chemical stability.

The performance of a PC-SOFC at low temperatures depends significantly on the ohmic resistance of the electrolyte, although it can be lowered by reducing the electrolyte thickness. Another important limiting factor is the increase of the cathode polarization resistance due to the thermally activated nature of the oxygen reduction reaction. For this reason, it is essential to obtain high efficiency cathodes operating at reduced temperatures.

In this work, $BaCe_{0.6}Zr_{0.2}Y_{0.2}O_{3-\delta}$ (BCZY) powders were prepared by freeze-drying precursor method. These powders were mixed with a Zn-containing solution as sintering additive in order to obtain dense pellets with submicrometric grain size at only 1200 ºC. After that, $La_{0.6}Sr_{0.4}Co_{0.8}Fe_{0.2}O_3$ nanocrystalline electrodes were deposited symmetrically onto dense pellets BCZY by conventional spray-pyrolysis [3]. The structure, microstructure and electrochemical properties of these electrodes have been examined by XRD, FE-SEM and impedance spectroscopy. The stability of these electrodes at intermediate temperatures was evaluated as a function of time.

These nanocrystalline cathodes exhibit a substantial improvement of the electrode polarization resistance with respect to the same materials prepared by screen-printing method at high sintering temperatures, e.g. 0.7 and 3.2 Ωcm^2 at 600ºC for LSCF cathodes prepared by spray-pyrolysis and screen-printing method respectively (Fig. 1).
An anode supported cell with composition LSCF/BCZY/NiO-BCZY was also prepared to test the electrochemical performance.

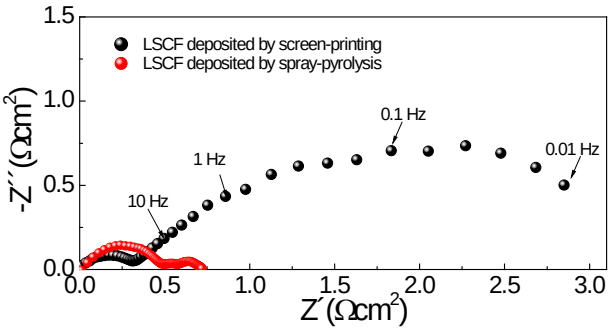

Fig. 1. Impedance spectra of LSCF cathodes deposited by spray-pyrolysis and conventional screen-printing on BCZY electrolytes.

2 Acknowledgements

This work was supported by MINECO through the MAT2013-41836-R research grant (Spain) which is co-funded by FEDER. Lucía dos Santos-Gómez thanks to the Spanish MECD for her FPU grant.

3 References

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